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EPA Nine Factor Analysis for Defining the 24-Hour PM_{2.5} NAAQS Nonattainment Area Boundary for Ravalli County, Montana

Montana Department of Environmental Quality
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Background

Based upon ambient air quality monitoring for years 2004 through 2006, PM_{2.5} monitoring data from the Ravalli County Courthouse [30-081-0001] and County Parking Lot [30-081-0007] sites measured a violation of the federal 24-hour PM_{2.5} standard of 35 micrograms per cubic meter (µg/m³). The Montana Department of Environmental Quality (DEQ) applied the '*Nine Factors*' identified in the April 1, 2003 Environmental Protection Agency (EPA) guidance "Designations for the Fine Particle National Ambient Air Quality Standards" to evaluate the geographic extent of the proposed PM_{2.5} nonattainment area for Ravalli County. The nine factors are outlined below:¹

- Emissions in areas potentially included versus excluded from the nonattainment area;
- Air quality in potentially included versus excluded areas;
- Population density and degree of urbanization including commercial development in included versus excluded areas;
- Traffic and commuting patterns;
- Expected growth (including extent, pattern and rate of growth);
- Meteorology (weather/transport patterns);
- Geography/topography (mountain ranges or other air basin boundaries);
- Jurisdictional boundaries (e.g. counties, air districts, Reservations, etc.); and
- Level of control of emission sources.

The Governor of Montana will propose all of Ravalli County as the PM_{2.5} nonattainment area. A summary of the nine factor criteria in support of this recommendation is described in the subsequent sections. All information is based upon the most recent, best available data. Where applicable, data representing the counties adjacent to Ravalli County are also included for comparison purposes. One adjacent county, Missoula County, is emphasized since air quality monitoring within this county also revealed a violation of the 24-hour PM_{2.5} standard. The Missoula City-County Health Department staff is responsible for the Nine Factor analysis for Missoula County.

¹ .Jeffrey Holmstead. EPA. .April 1, 2003. "Designations for the Fine Particle National Ambient Air Quality Standards".

DRAFT

Ravalli County does not contain any metropolitan statistical areas (MSA) as defined by the Office of Management and Budget and the entire county can be classified as “rural” based on the EPA’s definition of an area containing a population less than 50,000.^{2,3} In contrast, Missoula County contains a metropolitan statistical area, Missoula MSA, as defined by the Office of Management and Budget and used by the U.S. Census Bureau.⁴

The DEQ believes the Ravalli County airshed is not continuous with the Missoula County airshed during stagnant wintertime wind conditions. Specifically, under these conditions, these adjacent airsheds do not exchange air emissions from one county into the next. Table 1 lists the 98th percentile 24-hour PM_{2.5} concentrations that violated the 24-hour federal PM_{2.5} standard for both Ravalli and Missoula Counties from 2004 through 2006.

Table 1: Ravalli and Missoula Counties 98th Percentile 24-Hour PM_{2.5} Concentrations, 2004 – 2006.

| City - County | Year | | | Average ² (µg/m ³) |
|---|---|------------------------------|------------------------------|--|
| | 2004 (µg/m ³) ¹ | 2005 (µg/m ³) | 2006 (µg/m ³) | |
| Hamilton - Ravalli County | 44.7 | 40.7 ³ | 27.8 | 37.7 |
| Missoula - Missoula County ⁴ | 46.8 | 42.5 | 34.3 | 41.2 |

¹ µg/m³ = micrograms per cubic meter.

² The final site averages for the 24-hour period were based on the 3 year period from 2004 through 2006.

³ The current site (30-081-0007) didn't meet data completeness requirements in 2005 because the monitor was moved from the original Ravalli County monitoring site (30-081-0001). The 2005 data represents combined data from both of these sites to estimate the 98th percentile value.

⁴ The Missoula PM_{2.5} monitoring site ID is 30-081-0007.

Regardless of the year, the PM_{2.5} concentrations measured in Hamilton were lower than in Missoula. During the years with concentrations greater than 35.0 µg/m³, Hamilton had about 4 percent lower concentrations. However, during 2006, the 98th percentile PM_{2.5} concentration was about 19 percent lower. For the three-year period average, the concentration in Missoula was over 9 percent higher than for Hamilton. The concentrations and corresponding days that determined the 98th percentile listed in Table 1 are given in Table 2 and are noted by asterisks (*).

² 65 FR 249. Office of Management and Budget. Standards for Defining Metropolitan and Micropolitan Statistical Areas; Notice. December 27, 2000. ONLINE: <http://www.census.gov/population/www/estimates/00-32997.pdf>.

³ 69 FR 110. EPA. Rural Business Investment Program. June 8, 2004. ONLINE: <http://www.epa.gov/fedrgstr/EPA-IMPACT/2004/June/Day-08/i12731.htm>.

⁴ U.S. Census Bureau. Current Lists of Metropolitan and Micropolitan Statistical Areas and Definitions. ONLINE: <http://www.census.gov/population/www/estimates/metrodef.html>.

DRAFT

Also included are any additional days with PM_{2.5} concentrations greater than 35.0 µg/m³ that were measured at both monitoring sites. As evident in Table 2, only the monitor in Missoula County recorded such events. The dates that were common for both sites are emphasized in this table by bold font in addition to the corresponding concentrations.

DRAFT

Table 2: Dates of Ravalli and Missoula Counties 98th Percentile 24-Hour PM_{2.5} Concentrations Including Other High Concentrations Days, 2004 – 2006.

| City - County | 2004 | | | 2005 | | | 2006 | | |
|---------------------|----------------|-------------------------------|---|------|-----------------------|--|------|------------------------|--|
| | n ¹ | Date | PM _{2.5} Concentration (µg/m ³) ² | n | Date | PM _{2.5} Concentration (µg/m ³) | n | Date | PM _{2.5} Concentration (µg/m ³) |
| Hamilton - Ravalli | 110 | 1/10 1/16 1/01 | 64.0* ³ 45.5* 44.7* | 83 | 12/12 1/10 1/16 | 52.8* 40.7* 37.3 | 54 | 12/07 12/19 | 30.5* 27.8* |
| Missoula - Missoula | 111 | 1/16 1/10 1/19 12/17 | 62.3* 55.4* 46.8* 36.6 | 111 | 1/19 12/12 12/9 | 62.5* 54.0* 42.5* | 120 | 11/28 12/10 8/30 | 43.2* 36.2* 34.3† |

¹ n = number of samples collected during the year.

² µg/m³ = micrograms per cubic meter.

³ "*" denotes the values that were used in the 98th percentile compliance calculation.

⁴ "†" denotes the value was influenced by wildfire, but not eligible for exclusion by EPA.

As displayed in Table 2, Ravalli County recorded six days greater than 35.0 µg/m³ over the three years, whereas Missoula County recorded nine days greater than this concentration. Therefore, there were nine total days with PM_{2.5} concentrations greater than 35.0 µg/m³ measured at both monitoring sites. Three days out of nine (33%) were common for both sites: 1/10/04, 1/16/04, and 12/12/05. On 1/10/04 and 12/12/05, the concentrations were within about 2 percent of each other. On 1/16/04, the PM_{2.5} concentration measured in Missoula was about 37 percent higher than in Hamilton. From this comparison, high PM_{2.5} concentrations recorded in Missoula doesn't necessarily determine high concentrations will be measured in Hamilton. There may be a 20 percent correlation; however, after examining the wind speeds and directions for some of these days under Factor 6, Meteorology, there is really little correlation.

DRAFT

Table 3 illustrates the annual PM_{2.5} standard compliance calculation for comparison to the 15.0 µg/m³ federal standard for both Ravalli and Missoula Counties. Note that the annual means in this table are arithmetic means and not quarterly means as described in 40 CFR Part 50 Appendix N. As seen from Table 3, neither county was close to violating the federal annual PM_{2.5} standard.

Table 3: Arithmetic PM_{2.5} Annual Mean Compliance Calculation.

| City - County | Year | | | Average ² (µg/m ³) |
|----------------------------------|---|------------------------------|------------------------------|--|
| | 2004 (µg/m ³) ¹ | 2005 (µg/m ³) | 2006 (µg/m ³) | |
| Hamilton - Ravalli | 8.53 | 8.94 ³ | 8.34 | 8.60 |
| Missoula - Missoula ⁴ | 10.7 | 11.09 | 9.50 | 10.43 |

¹ µg/m³ = micrograms per cubic meter.

² The final site averages for the annual standard were based on the 3 year period from 2004 through 2006.

³ The current site (30-081-0007) didn't meet data completeness requirements in 2005 because the monitor was moved from the original Ravalli County monitoring site (30-081-0001). The 2005 data represents combined data from both of these sites to estimate the annual average value.

⁴ The Missoula PM_{2.5} monitoring site ID is 30-081-0007.

Ravalli County is located in southwestern Montana and extends nearly 100 miles from the Missoula border to Lost Trail Pass at the Idaho border. U.S. Highway 93 is the major north-south highway running through the county. Ravalli County is often referred to as the "Bitterroot Valley" and encompasses the Sapphire Mountains to the east, and the Bitterroot Mountains to the west, which are the headwaters to the Bitterroot River. The five adjacent counties are as follows in alphabetical order:

- Southeast - Beaverhead, Montana (MT)
- East - Granite, MT
- North – Missoula, MT
- West - Idaho, Idaho (ID)
- South - Lemhi, ID

According to the 2000 U.S. Census, Ravalli County had a total area of 2,394.21 square miles (mi²) or 6,201.00 square kilometers (km²). The total 2000 population was 36,070 residing in 14,289 occupied households (15,496 total housing units or 92 percent occupancy) within 10,182 families. Using this information for 2000, the population density is estimated to be approximately 15.1/mi² (5.8/km²) with an average housing density of approximately 6.5/mi² (2.5/km²).⁵ However, as discussed under Factor 3 (population density), only about 25 percent of the land in Ravalli County is privately-owned, therefore the population and average housing densities was actually about

⁵ Census and Economic Information Center. Demographic & Economic Information for Ravalli County. ONLINE:

(http://www.ourfactsyourfuture.org/admin/uploadedPublications/1598_Ravalli_CF06_Web.pdf).

DRAFT

60/mi² and 26/mi², respectively, in the year 2000. The seven communities in Ravalli County with 2000 U.S. Census data relating to population, number of housing units, number of occupied housing units, and percentage of occupancy is provided in Table 4.

Table 4: Ravalli County Communities, 2000 U.S. Census Population, and Housing Units Occupancy.¹

| Community | Population | Number of Housing Units | Number of Occupied Housing Unit | Percent Housing Occupancy (%) |
|------------------------------|------------|-------------------------|---------------------------------|-------------------------------|
| Corvallis CDP ² | 443 | 198 | 185 | 93.4 |
| Darby Town ³ | 710 | 2,316 | 279 | 88.3 |
| Florence CDP | 901 | 336 | 323 | 96.1 |
| Hamilton City ^{4,5} | 3,705 | 1,915 | 1,772 | 92.5 |
| Pinesdale Town | 742 | 149 | 139 | 93.2 |
| Stevensville Town | 1,553 | 711 | 652 | 91.7 |
| Victor CDP | 859 | 375 | 351 | 93.6 |

¹ U.S. Census Bureau Quickfacts Report. 2000. Table DP-1. Profile of General Demographic Characteristics: 2000. ONLINE: (<http://quickfacts.census.gov/cgi-bin/qfd/demolink?30>).

² CDP = Census Designated Place(s); a geographic unincorporated place; a statistical definition assigned by the Office of Management and Budget (OMB) and used by the U.S. Census Bureau.

³ Town = a type of geographic incorporated place with local government; a statistical definition assigned by the Office of Management and Budget (OMB) and used by the U.S. Census Bureau.

⁴ City = a type of geographic incorporated place with local government; a statistical definition assigned by the Office of Management and Budget (OMB) and used by the U.S. Census Bureau.

⁵ County seat.

The total 2000 population of these seven communities was 8,913 or about 25 percent of Ravalli County residents lived in a recognized U.S. Census Bureau geographic area. Currently, there are only four incorporated towns in Ravalli County: Darby, Hamilton, Pinesdale, and Stevensville. Together in 2000, these communities contained about 19 percent of the County population. Another six communities are located in Ravalli County, but were not listed in Table 4 since 2000 U.S. Census data were unavailable: Alta, Connor, Grantsdale, Lost Trail Camp, Sula, and Woodside. All communities are included in the proposed PM_{2.5} Ravalli County nonattainment area.

Historically, the economy of Ravalli County relied predominantly on agriculture and timber. Logging operations supplied lumber to support area mining activities. However, current Ravalli County economy primarily stems from retail trade. Other significant sectors include the following: Health Care and Social Assistance, Educational Services, Manufacturing, and Accommodation & Food Services (related to tourism). However,

DRAFT

the sectors that have seen the most growth in recent years are related to wholesale trade including Arts, Entertainment and Recreation, Mining, and Construction, which have all shown double-digit growth from 2004 to 2005.⁶

The dominant source of particulates in Ravalli County is from area sources since few point sources exist in the county (Factor 9). Ravalli County serves as a 'bedroom' community to the more urban northern Missoula area since Hamilton, the largest town in Ravalli County, is less than 50 miles away. Therefore, vehicle traffic movement north and south along U.S. Highway 93 is significant since alternative forms of transportation such as public transportation (bus service) is limited and light rail is non-existent.

The greater Missoula urban area is also a proposed 24-hour PM_{2.5} nonattainment area (NAA). The proposed Ravalli County PM_{2.5} NAA boundary (the entire County) is contiguous to the proposed Missoula 24-hour PM_{2.5} NAA boundary in order to provide some uniform regulatory control measures while observing the necessary administrative separation (Factor 8).

Another large source of PM_{2.5} emissions in Ravalli County occurs during the spring through fall seasons from wildland fires and prescribed burning activities in the surrounding timber and rangelands. Long distance transport of fire activities in Idaho also impact Ravalli County. Emissions from prescribed burning are currently addressed under the state Smoke Management program. Emissions from wildfires are also addressed through the Exceptional Events Rule whereby states may flag monitoring data that exceed the federal air quality standards that are determined to be influenced by wildfire. EPA concurs such data are not considered when making nonattainment determinations.

The proposed Ravalli County PM_{2.5} nonattainment area is the entire county. The County was created effective April 1, 1893 and the legal description is as follows: Beginning at the intersection of the boundary line between Montana and Idaho with the line dividing townships ten (10) and eleven (11) north, range twenty-two (22) west, and running thence in a general southerly direction following said boundary line to an intersection of the summit of the Bitter Root mountains with the continental divide, said intersection being six (6) miles, more or less, northwest of the crossing of the Dehalonega pass; thence running in a general northeasterly direction along the top of the continental divide to an intersection with the summit of the divide between Bitter Root river and Rock creek; thence following the summit of said divide in a northerly direction to its intersection with the north line of township ten (10) north, range eighteen (18) west; thence following the line between township ten (10) north and eleven (11) north, west to the point of beginning.⁷

⁶ Census and Economic Information Center. Montana Department of Commerce. Research & Analysis Bureau. Demographics & Economic Information for Ravalli County. ONLINE: (http://www.ourfactsyourfuture.org/admin/uploadedPublications/1598_Ravalli_CF06_Web.pdf).

⁷ Montana State Legislature. ONLINE: (http://leg.mt.gov/content/mtcode_const/sup_mat_annon/description_of_county_boundaries.pdf).

The DEQ describes geographic planning areas using the Montana State Plane Coordinate System (SPCS), zone 2500, North American Datum 1983 (NAD83), using approximately 25 kilometers (km) by 25 km (625 km²) sized grids, which are roughly 241 mi². These planning areas are used for air pollution control programs including, but not limited to, nonattainment planning areas. The SPCS coordinate system is easily defined, readily mapped, and recognized federally and globally for describing geographic points and areas.⁸

Factor 1: Emissions And Air Quality In Adjacent Areas (Including Adjacent Consolidated Metropolitan Statistical Areas (CMSAs) And Metropolitan Statistical Areas (MSAs))

As previously mentioned, the Ravalli County does not contain any metropolitan statistical areas (MSA) as defined by the Office of Management and Budget and the entire county can be classified as “rural” based on the EPA’s definition of an area containing a population less than 50,000. In contrast, Missoula County contains a metropolitan statistical area, Missoula MSA, as defined by the Office of Management and Budget and used by the U.S. Census Bureau.

The PM_{2.5} emissions, and therefore, the corresponding concentrations also include secondary fine particulates. Secondary particulates are the result from precursor emissions of ammonia (NH₃), nitrous oxides (NO_x), sulfur dioxide (SO₂), and volatile organic carbons (VOC or VOCs). Therefore, for Factor 1, DEQ reviewed the annual emissions in tons per year (tpy) from these secondary fine particulates in addition to the crustal PM_{2.5} for Ravalli and adjacent counties based on the 2001 National Emission Inventory (NEI) as shown in Table 5. The primary and filterable PM_{2.5} emissions were combined to characterize the crustal PM_{2.5} emissions. Table 5 also displays the proportion of the annual emissions from the surrounding counties relative to the Ravalli County emissions.

The emissions in Table 5 represented four general source categories: point, area, onroad mobile, and nonroad mobile. Onroad mobile emissions occurred on both paved and unpaved roads. The nonroad sources included 2- and 4- stroke and diesel engines, construction equipment, aircraft, and locomotives. Area sources included residential wood combustion (wood stoves, etc.), residential fossil fuel combustion, and agricultural production practices including burning. It should be noted that these emissions should be evaluated proportionally since DEQ did not submit state-specific data for the 2001 NEI. The state of Idaho did submit area source data, but only some point source data.

⁸ DEQ. Montana Clean Air Act Section 107(d) Planning Areas Map. Available Upon Request.

DRAFT

Table 5: Estimated 2001 NEI Ravalli and Surrounding Counties SO₂, NO_x, VOC, NH₃, and PM_{2.5} Emissions, and Percent Relative to Ravalli County.¹

| County - State | State + County FIPS ² | SO ₂ (tpy) ³ | Percent of Ravalli (%) | NO _x (tpy) | Percent of Ravalli (%) | VOC (tpy) | Percent of Ravalli (%) | NH ₃ (tpy) | Percent of Ravalli (%) | Crustal PM _{2.5} (tpy) | Percent of Ravalli (%) | Total (tpy) | Percent of Ravalli (%) |
|-----------------|----------------------------------|---------------------------------------|------------------------|--------------------------|------------------------|--------------|------------------------|--------------------------|------------------------|------------------------------------|------------------------|----------------|------------------------|
| Ravalli - MT | 03-081 | 157 | NA ⁴ | 2,147 | NA | 2,518 | NA | 1,072 | NA | 5,327 | NA | 11,221 | NA |
| Beaverhead - MT | 30-001 | 228 | 145.2 | 1,877 | 87.4 | 2,147 | 85.3 | 3,560 | 332.1 | 3,663 | 68.8 | 11,475 | 102.3 |
| Granite - MT | 30-039 | 166 | 105.7 | 2,038 | 94.9 | 802 | 31.9 | 710 | 66.2 | 1,506 | 28.3 | 5,222 | 46.5 |
| Missoula - MT | 30-063 | 824 | 524.8 | 11,209 | 522.1 | 7,191 | 285.6 | 515 | 48.0 | 7,532 | 141.4 | 27,271 | 243.0 |
| Idaho - ID | 16-049 | 1,441 | 917.8 | 6,267 | 291.9 | 15,473 | 614.5 | 2,455 | 229.0 | 26,472 | 496.9 | 52,108 | 464.4 |
| Lemhi - ID | 16-059 | 749 | 477.1 | 3,188 | 148.5 | 7,686 | 305.2 | 1,947 | 181.6 | 12,350 | 231.8 | 25,920 | 231.0 |

¹ EPA. Criteria Pollutant Emissions Summary Files. 2001. File: sccsummarymade09192005.txt. ONLINE:

(http://ftp.epa.gov/pub/EmissionInventory/NEI_criteria_summaries/2001criteria_summaryfiles/).

² The five character state and county codes are assigned by the Federal Identification Program System (FIPS).

³ tpy = tons per year.

⁴ NA = Not Applicable.

For the 2001 NEI, only Granite County had less total emissions than Ravalli County. About 50 percent of the 2001 NEI estimated Ravalli County emissions were crustal and the other fraction was composed of the precursor emissions for secondary particulate formation. The very high Idaho County PM_{2.5} emissions were due to wildfire activities. In comparison to Missoula County, the Ravalli County emissions were about 40 percent. Table 6 lists the source contributions by pollutant for each county as determined by the 2001 NEI.

DRAFT

Table 6: 2001 NEI Percent Source Contributions to the Ravalli and Surrounding Counties SO₂, NO_x, VOC, NH₃, and PM_{2.5} Emissions.¹

| Pollutant | Source Type | Percentage Source Contribution by County (%) | | | | | |
|---------------------------|-----------------------------|--|-----------------|--------------|---------------|------------|------------|
| | | Ravalli - MT | Beaverhead - MT | Granite - MT | Missoula - MT | Idaho - ID | Lemhi - ID |
| SO ₂ | Point | 0.0 | 0.4 | 0.0 | 21.8 | 0.2 | 0.0 |
| | Area | 59.3 | 70.7 | 34.3 | 35.8 | 95.3 | 97.2 |
| | Onroad Mobile | 31.8 | 10.5 | 5.4 | 10.6 | 1.2 | 0.9 |
| | Nonroad Mobile | 8.9 | 18.4 | 60.3 | 31.8 | 3.3 | 1.9 |
| NO _x | Point | 0.0 | 1.3 | 0.0 | 26.8 | 0.1 | 0.0 |
| | Area | 20.4 | 32.6 | 10.9 | 18.2 | 84.7 | 89.9 |
| | Onroad Mobile | 73.1 | 46.2 | 15.7 | 23.6 | 8.8 | 6.6 |
| | Nonroad Mobile | 6.5 | 19.9 | 73.4 | 31.5 | 6.4 | 3.5 |
| VOC | Point | 0.0 | 0.0 | 0.0 | 14.6 | 0.4 | 0.0 |
| | Area | 58.9 | 74.4 | 67.6 | 51.4 | 95.3 | 91.7 |
| | Onroad Mobile | 33.0 | 17.4 | 17.3 | 24.2 | 1.9 | 1.5 |
| | Nonroad Mobile | 8.1 | 8.2 | 15.1 | 9.8 | 2.4 | 6.8 |
| NH ₃ | Point | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| | Area | 95.9 | 99.4 | 98.8 | 83.9 | 99.4 | 99.6 |
| | Onroad Mobile | 4.0 | 0.6 | 1.1 | 15.7 | 0.6 | 0.3 |
| | Nonroad Mobile | 0.1 | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 |
| Crustal PM _{2.5} | Point ² | 0.0 | 0.6 | 0.0 | 22.8 | 0.5 | 0.0 |
| | Area ² | 99.0 | 97.8 | 96.6 | 74.8 | 99.3 | 99.9 |
| | Onroad Mobile ³ | 0.7 | 0.5 | 0.5 | 0.7 | 0.0 | 0.0 |
| | Nonroad Mobile ³ | 0.3 | 1.1 | 2.9 | 1.7 | 0.2 | 0.1 |

¹ NEI = National Emission Inventory; EPA. Criteria Pollutant Emissions Summary Files. 2001. File: tier3summarymade09082005.txt. ONLINE: (ftp://ftp.epa.gov/pub/EmisInventory/nei_criteria_summaries/2001criteria-summaryfiles/).

² Crustal PM_{2.5} point and area included both the primary and filterable PM_{2.5}.

³ Crustal PM_{2.5} onroad and nonroad mobile were primary PM_{2.5} only.

Most of the annual PM_{2.5} emissions in Ravalli County were from area sources followed by onroad mobile sources. Unpaved road dust dominated the crustal component. Over 70 percent of the Ravalli County NO_x emissions were from onroad mobiles sources. Cattle husbandry was almost 84 percent of the ammonia emissions and almost 40 percent of the VOCs emissions were from wildfires, which cannot be considered when determining the NAA boundary. In 2001, the Ravalli County had no significant point sources; the emissions from the current three point sources are discussed in Factor 9.

DRAFT

Due to the topographical features and meteorology described later, DEQ believes by proposing the entire county as the PM_{2.5} NAA boundary, it captures all sources that currently cause or contribute to the PM_{2.5} emissions and any future violations of the federal 24-hour PM_{2.5} standard in Ravalli County.

Factor 2: Air Quality In Potentially Included Versus Excluded Areas

Federal reference monitoring data is unavailable except for Ravalli and Missoula Counties to compare the 98th percentile PM_{2.5} design values. However, other sources of data is available to compare the emission sources in Ravalli and Missoula Counties.

A PM_{2.5} chemical mass balance (CMB) study was conducted in Hamilton, Ravalli County, from November 7, 2006 through February 27, 2007.⁹ The objective was to identify the PM_{2.5} sources in the Bitterroot Valley airshed during the wintertime when the highest PM_{2.5} concentrations occur. Unfortunately, only eleven of the proposed nineteen samples were collected due to sampling error. Therefore, another study will be conducted during the 2007 - 2008 winter season.

Preliminary results from the 2006 - 2007 winter CMB study found an average PM_{2.5} concentration of 11.6 µg/m³ with the highest concentration, 30.5 µg/m³, measured on December 7, 2006. Based on the speciation data, residential wood combustion composed almost 84 percent (83.6%) of the average concentration, with only 2 percent explained by automobile emissions. Ammonium nitrate contributed 13 percent to the average concentration. On the highest PM_{2.5} concentration day, residential wood combustion and ammonium nitrate contributed over 84 percent and 17 percent, respectively, to the PM_{2.5} concentration. The area ammonia (cattle) and mobile NOx emissions estimated by the 2000 NEI nitrate probably contributed to the ammonium nitrate identified by this CMB study.

A simultaneous CMB study was also conducted in Missoula.¹⁰ Again, the objective was to identify the PM_{2.5} sources in the Missoula Valley airshed during the wintertime, which is also the period when the highest PM_{2.5} concentrations occur. In this case, twenty-six samples were successfully collected and analyzed. The average PM_{2.5} concentration was 15.4 µg/m³ with the highest concentration, 43.2 µg/m³, measured on November 28, 2006. Unfortunately, a corresponding Hamilton sample was not collected on this day for comparison. Based upon the speciation data, residential wood combustion composed almost 56 percent (55.5%) of the average concentration, with only 1 percent explained by automobile emissions. Ammonium nitrate contributed 19 percent to the average concentration. On the highest PM_{2.5} concentration day, residential wood combustion

⁹ Ward, Tony J. August 1, 2007. The Hamilton, Montana PM_{2.5} Source Apportionment Research Study. Center for Environmental Health Sciences. The University of Montana – Missoula. Skaggs Building 17B. Missoula MT 59812.

¹⁰ Ward, Tony J. September 1, 2007. The Missoula, Montana PM_{2.5} Source Apportionment Research Study. Center for Environmental Health Sciences. The University of Montana – Missoula. Skaggs Building 17B. Missoula MT 59812.

DRAFT

and ammonium nitrate contributed over 60 percent and 10 percent, respectively. On December 7, 2006, the day that measured the highest PM_{2.5} concentration during the Hamilton CMB study, an error in the data occurred at this site.

Four source profiles were common in both CMB studies: automobiles, ammonium nitrate, residential wood combustion, and street sand. The Hamilton study also used one other source profile, secondary sulfate, which contributed about 2 percent of the average PM_{2.5} concentration. The Missoula CMB study identified three relatively significant contributing sources not identified in the Hamilton study. Relative to the average PM_{2.5} concentration, these sources were diesel (~ 5%), kraft recovery boiler (7%), and hog fuel boilers (~ 12%). The higher diesel vehicle population and the presence of a locomotive switch yard in the Missoula area were probably factors. A major Missoula point source, Smurfit-Stone Container Corporation, uses both types of boilers in their pulp mill process, which were identified in the CMB study. The lack of both diesel and the boiler as emission sources in the Hamilton CMB analyses indicates there was no or very little exchange of air between the Missoula and Ravalli airsheds during the wintertime when the highest PM_{2.5} concentrations consistently occur in both counties.

Factor 3: Population Density and Degree of Urbanization Including Commercial Development In Included Versus Excluded Areas

Table 7 provides the land area, estimated 2004 through 2006 populations, and 2006 population densities for Ravalli and adjacent counties.

Table 7: Land Area, Recent Population Estimates, and Density in Ravalli and Adjacent Counties.

| County - State | Land Area (mi ²) ¹ | 2004 Population | 2005 Population | 2006 Population | 2006 Population Density (persons/mi ²) |
|---------------------------------|---|-----------------|-----------------|-----------------|--|
| Ravalli - MT ^{2, 3} | 2,394.21 | 39,417 | 39,822 | 40,582 | ~ 17 (16.95) |
| Beaverhead - MT ^{2, 3} | 5,542.31 | 8,832 | 8,778 | 8,743 | < 2 (1.58) |
| Granite - MT ^{2, 3} | 1,727.44 | 2,893 | 2,932 | 2,909 | < 2 (1.68) |
| Missoula - MT ^{2, 3} | 2,597.97 | 99,031 | 100,033 | 101,417 | ~ 39 (39.04) |
| Idaho - ID ^{4, 5} | 8,484.88 | 15,637 | 15,659 | 15,762 | < 2 (1.86) |
| Lemhi - ID ^{4, 5} | 4,564.16 | 7,827 | 7,868 | 7,930 | < 2 (1.74) |

¹ mi² = square mile.

² Census and Economic Information Center. Montana Department of Commerce. 2000 U.S. Census. CENSUS 2000 PUBLIC LAW 94-171 REDISTRICTING DATA – PLACE. ONLINE: (<http://ceic.mt.gov/C2000/PL2000/PLcountyarea.pdf>).

DRAFT

Census and Economic Information Center. Montana Department of Commerce. Components of Change and Total Population. Table 1. Annual Estimates of the Population, 2000-2006. ONLINE: (<http://ceic.mt.gov/Demog/estimate/pop/County/CO-EST2006-01-30.htm>).

⁴ U.S. Census Bureau. 2000 U.S. Census. State and County QuickFacts. ONLINE: (<http://quickfacts.census.gov/qfd/states/16000.html>).

Most of the counties had very low population densities (~ 2 people/mi²), except for Ravalli and Missoula Counties, which were significantly higher (at least 8.5 times higher). Missoula County population density was over two times higher than Ravalli County. The potential for commercial and residential development is relatively limited in Ravalli County since over 70 percent of the county is public forest lands, mostly U.S. Forest Service, and only about 25 percent was privately-owned as shown in Figure 1.

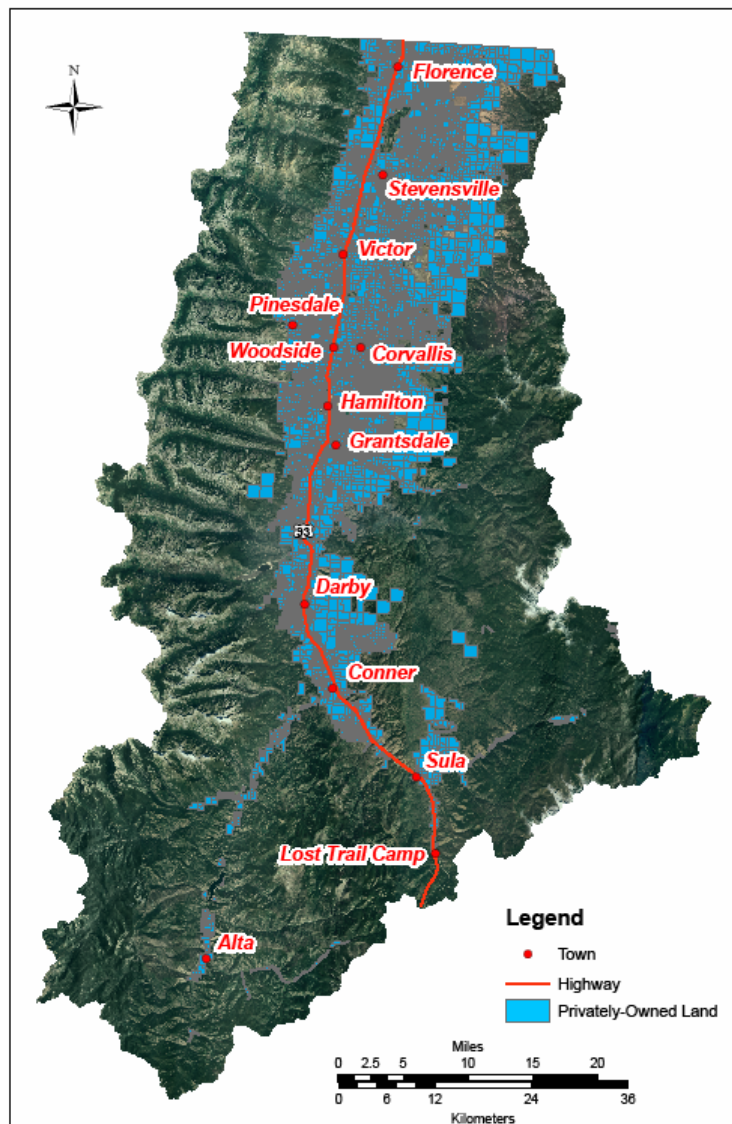


Figure 1: 2007 Ravalli County Privately-Owned Land.¹

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The Missoula City-County Health Department provided the maps that are displayed in Figure 2. Although the entire Ravalli County was not included, the most northern area adjacent to Missoula County is displayed. The red areas primarily indicate residences.

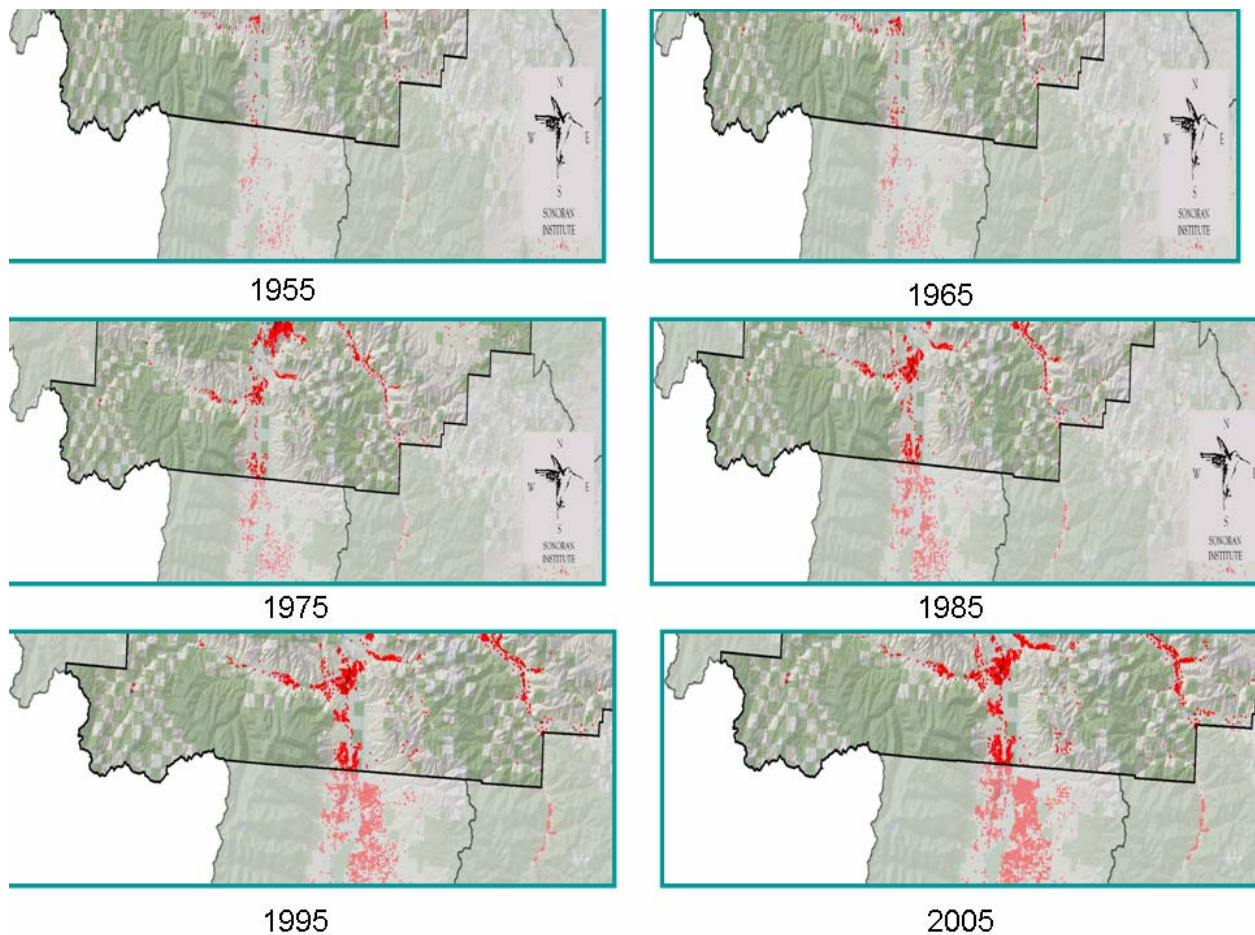


Figure 2: Ravalli County Growth Pattern, 1955 - 2005.¹

¹ Courtesy: Sonoran Institute.

As seen in Figure 2, heavy residential development has occurred south of Missoula into Ravalli County, particularly into east. Some land looks open for growth, but Ravalli County is still in the process of developing the zoning regulations (<http://www.ravallcounty.mt.gov/planning/Zoning.htm>).

Finally, the growth of Ravalli County businesses indicates commercial / industrial development. Table 8 lists the number of business establishments, number of employees, and sales receipts for Ravalli County in 1993, 1997, and 2002.

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Table 8: Ravalli County Number of Business Establishments and Employees, and Sales Receipts: 1992, 1997, and 2002.¹

| Business Characteristic | 1992 | 1997 | 2002 | 1992 – 1997 Annual Percent Increase (%) | 1992 – 2002 Annual Percent Increase (%) |
|----------------------------|-------|-------|-------|---|---|
| Number of Establishments | 504 | 624 | 843 | 4.8 | 6.7 |
| Number of Employees | 3,400 | 4,433 | 5,685 | 6.1 | 6.7 |
| Sales Receipts (\$Million) | 320 | 525 | 625 | 9.5 | 9.5 |

¹ U.S. Census Bureau. 1992. ONLINE: (<http://www.census.gov/epcd/www/92profiles/county/30081.TXT>).

² U.S. Census Bureau. 1997. ONLINE: (<http://www.census.gov/epcd/ec97/mt/MT081.HTM>).

³ U.S. Census Bureau. 2002. ONLINE: (<http://www.census.gov/econ/census02/data/mt/MT081.HTM>).

Over the ten year period from 1992 to 2002, Ravalli County had about 7 percent annual increase in both number of establishments and employees, and 10 percent increase in million dollar sales receipts. However, as discussed earlier, most of these businesses were tourist-related with some construction and manufacturing. Based on the analysis for this factor, commercial development was and will probably continue to be limited due to unavailable land.

Factor 4: Traffic and Commuting Patterns

Vehicle exhaust, and tire and brake wear are all sources of PM_{2.5}. Therefore, the commuting pattern of the Ravalli County residents is important to characterize. The Department of Transportation (MDT) Traffic Automatic Recorders (ATR) on U.S. Highway 93 that connects Ravalli and Missoula Counties were reviewed for the most recent ten years of data. Ravalli County had two sites: A-47 (north of Stevensville, which is closer to Missoula) and A-56 (north of Hamilton). No ATRs exists on U.S. Highway 93 between Missoula and Ravalli Counties on the Missoula County side. Table 9 lists the annual average daily traffic (AADT) for these sites for 1997 through 2006. It should be noted that the AADTs were adjusted by MDT for the time of year and day of the week.

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Table 9: MDT Automatic Traffic Recorders AADT Data on U.S. Highway 93, Ravalli County, 1997 – 2006.

| Recorder Code (Location) | Year of AADT ¹ | | | | | | | | | | Annual Percent VMT Change (%) ² |
|---------------------------------|---------------------------|--------|--------|--------|--------|--------|--------|------------------|--------|--------|--|
| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | |
| A-47 (north of Stevensville) | 7,973 | 8,833 | 8,873 | 8,989 | 9,322 | 9,625 | 9,907 | N/A ³ | N/A | 9,477 | 1.94 |
| A-56 (north of Hamilton) | 9,795 | 10,211 | 10,605 | 10,605 | 10,741 | 11,078 | 11,183 | 11,333 | 11,243 | 11,352 | 1.65 |

¹ AADT = annual average daily traffic; MDT. Statistics and Data. Montana's Automatic Traffic Recorders 2006. ONLINE: <http://www.mdt.mt.gov/publications/docs/datastats/atr/atrbook06.pdf>.

² Annual VMT change = $(\text{EXP}(\text{LN}(D12/D11)) / (C12 - C11)) - 1$ (Cyra Cain, DEQ, personal communication, Al Vander Wey, Montana Department of Transportation, 2005).

³ N/A = Not Available.

The site closest to Missoula County had lower AADTs, about 17 percent lower in 2006, than the site further south within Ravalli County, but the annual VMT growth was slightly higher. The overall average of VMT percent change was about 1.80 percent. The MDT AADT 2005 rural traffic flow map for Ravalli County in Figure 3 shows slightly different values than the recorders, but the pattern of traffic is similar and the map also shows the traffic south of Hamilton. The numbers over the routes are the total AADTs with the truck AADTs underneath.



Traffic on U.S. Highway 93 between Hamilton and Connor at the junction with S-473 significantly decreased to about a third of the traffic north of Hamilton. Continuing south to the Idaho border, average annual daily traffic decreased by 75 percent.

Another indicator of traffic patterns is the commuting to work characteristics obtained from the 2000 U.S. Census. The U.S. Census Bureau classified workers as 18 years and older. Table 10 gives the 2000 U.S. Census data pertaining to number of workers and commuting patterns for Ravalli and adjacent counties.

Figure 3: 2005 Ravalli County Rural Traffic Flows.¹

¹ MDT. Montana Maps. 2005 Rural Traffic Flow Map. ONLINE: (http://www.mdt.mt.gov/travinfo/docs/2005_traffic_flow_map.pdf).

Table 10: U.S. 2000 Census Commuting Patterns of Ravalli and Adjacent Counties.¹

| County - State | Total Number of Workers | Number of Workers Worked in Home County | Number of Workers Commuted to Ravalli County | Percent of Workers Commuted to Ravalli County (%) |
|-----------------|-------------------------|---|--|---|
| Ravalli - MT | 15,362 | 11,766 | NA ² | NA |
| Beaverhead - MT | 4,403 | 4,126 | 5 | 0.1 |
| Granite - MT | 1,261 | 929 | 3 | 0.2 |
| Missoula - MT | 49,448 | 47,159 | 900 | 1.8 |
| Idaho - ID | 5,788 | 4,870 | 0 | 0.0 |
| Lemhi - ID | 3,097 | 2,999 | 0 | 0.0 |

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¹ U.S. Census Bureau. County-to-County Worker Flow Files. 2000. ONLINE:
(<http://www.census.gov/population/www/cen2000/commuting.html>).

² NA = Not Applicable.

About 77 percent of the Ravalli County workers remained in their home county to work while 21 percent (3,178) commuted to Missoula County. Assuming the 3,178 Ravalli County workers didn't carpool and worked a regular work schedule (5 days/week and 50 weeks/year), approximately 6,356 AADTs (about 71percent) of the 8,989 AADTs (Table 9) during 2000 were from the Ravalli County workers commuting to Missoula County. Essentially, the workers in the other adjacent counties did not commute to Ravalli County to work.

Factor 5: Growth Rates And Patterns

Table 11 shows the projected populations for Ravalli and adjacent counties from 2000 through 2030 in 5-year increments.

Table 11: Projected Populations for Ravalli and Adjacent Counties, 2000-2030, in 5-Year Increments.

| County - State | U.S. Census | Estimated | | | | | | 2000 – 2030 Annual Percent Increase (%) |
|------------------------------|-------------|-----------|---------|---------|---------|---------|---------|---|
| | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| Ravalli - MT ¹ | 36,070 | 39,940 | 44,710 | 50,100 | 55,500 | 60,960 | 66,670 | 2.83 |
| Beaverhead - MT ¹ | 9,202 | 8,773 | 8,920 | 9,260 | 9,630 | 10,070 | 10,570 | 0.50 |
| Granite - MT ¹ | 2,830 | 2,965 | 3,160 | 3,250 | 3,360 | 3,510 | 3,670 | 0.99 |
| Missoula - MT ¹ | 95,802 | 100,086 | 107,190 | 115,080 | 123,310 | 132,010 | 141,370 | 1.59 |
| Idaho - ID ² | 15,470 | 15,800 | 15,480 | 15,780 | 15,960 | 16,030 | 15,980 | 0.11 |
| Lemhi - ID ² | 7,750 | 7,940 | 8,430 | 9,060 | 9,660 | 10,200 | 10,720 | 1.28 |

¹ Census and Economic Center. Montana Department of Commerce. Montana Population Projections, Total Population. Source: NPA Data Services Inc. ONLINE: (http://ceic.mt.gov/Demog/project/NPAallcounties_1106_web.pdf).

² Alan Porter. Department of Labor. State of Idaho. Population Projections. October 3, 2007.

Ravalli County is projected to have the fastest population growth rate compared to the other counties, followed by Missoula County. The other Montanan counties are projected to have very low population growth in addition to Lemhi County, Idaho.

From 1970 to 2000, Ravalli County was one of the five fastest growing counties in Montana. In the 1990s, the largest jump in population occurred in Ravalli County and throughout the statewide. Between 1990 and 2000, the county's population jumped by 44.2 percent, from 25,010 to 36,940. Montana saw a statewide increase from 799,065 to 902,195, a respectable 12.9 percent increase.

According to Census and Information Center (CEIC), Montana Department of Commerce, the Ravalli County experienced 178 percent increase in population in unincorporated areas in comparison to a 74 percent increase in population in incorporated ones from 1970 to 2000.¹¹ Interestingly, from 2000 through 2005, the percentages have changed and a higher proportion of the population is moving into incorporated areas (19%) compared to unincorporated ones (9%).¹²

Hamilton was the biggest town at the start of that three-decade period from 1970 to 2000, at 2,499, and it was the biggest by the end in 2000, with 4,443 people. Stevensville started that period with 829 people, and ended with 1,553. Darby began with 538 and ended with 710. The first data for Pinesdale was the 1990 U.S. Census, when that town had a 670 population, which rose to 832 by 2000.

Factor 6: Meteorology

The Missoula and Bitterroot Valleys have much in common, but some significant and important differences exist as well. Both valleys are located west of the Continental Divide, both have steep slopes limiting lateral dispersion, and both are subject to intense and long lasting stagnation periods with strong persistent temperature inversions in the lower atmosphere. These stagnation periods are the root cause of the high PM_{2.5} ambient levels that have resulted in the nonattainment status of both areas.

With the exception of summer forest fire impacts, all of the highest measured PM_{2.5} levels occur during the winter months when these inversions are the strongest and most persistent. The problematic winter inversions are surface based during the night and

¹¹ Census and Economic Information Center. INCORPORATED VERSUS UNINCORPORATED AREAS PERCENT CHANGE 1970 – 2000. ONLINE: (http://www.ceic.mt.gov/graphics/Data_Maps/IncVsUninc1970-2000.pdf).

¹² Census and Economic Information Center. What the Numbers Say. ONLINE: (http://www.ceic.mt.gov/Publications/Newsletter_Fall_Winter_06_07_Final.pdf).

DRAFT

elevated during the day. The inversions are typically very strong ($+ 3^{\circ}\text{C}/100\text{m}$ or more) for the lowest 200 meters of the atmosphere during the nighttime hours into the early morning. During the late morning and afternoon, the atmosphere near the surface becomes somewhat adiabatic or at least isothermal for the lower 200-300 meters allowing some vertical mixing, but an elevated inversion remains in place trapping the pollutants in the valley over a period of several days, allowing the particulate levels to steadily rise until a synoptic event flushes the air out of the valley. During the nighttime hours when the surface-based inversion is at it's strongest, vertical mixing is almost nonexistent.

Smoke and other pollutants from area sources such as cars and woodstoves are trapped in a very shallow (10-30 meters) layer near the surface. This produces the characteristic "spike" of high $\text{PM}_{2.5}$ concentrations during the nighttime hours and during the morning commute.

With the vertical mixing issue, lateral dispersion is also severely limited during this period with many hours of "calm" wind speeds recorded at the surface. Winds aloft are totally decoupled from the surface by the stable inversion layer and there is almost no net transport of air out of either valley. Under these conditions, even "regional scale" pollutants like $\text{PM}_{2.5}$ with high residence times aloft become local issues with steep lateral concentration gradients as pollution stays very near the emission sources. Diurnal drainage flows are the only sources of air movement under these conditions and they do little to provide any net transport. The bottoms of both valleys are relatively flat and, once minor flows reach the valley floors from the side canyons, downslope gravity winds are minimal.

The three big differences between the Bitterroot and Missoula Valleys are their size, shape and orientation. The Bitterroot is long, narrow, and oriented north/south. The Missoula valley is more bowl shaped with five drainages converging before exiting out to the northwest. The minor amounts of drainage flows reaching the Missoula Valley from the Bitterroot under inversion conditions are very shallow and skirt the west edge of Missoula Valley in the low terrain before heading out past Frenchtown through the Clark Fork River Canyon. This physical separation of air from the Bitterroot Valley from the city of Missoula is why the CMB results from the two areas are so dissimilar. Specific weather analysis was evaluated and presented below.

Since the highest $\text{PM}_{2.5}$ concentrations consistently occur during the winter months, this factor analysis focused on the months January, February, and December. Table 12 lists the minimum, maximum, and average ambient air temperatures by month and county for each year 2004 through 2006. The codes representing the sites in this table and other tables in this section are either WBAN (5-digits) or COOP (Cooperative) IDs.

DRAFT

The acronym WBAM is used at National Climatic Data Center for digital data storage and general station identification purposes, which stands for Weather-Bureau-Army-Navy. The Philipsburg Ranger Station ID is a WIMS (Weather Information Management System) code. Further analysis of the specific meteorological conditions that occurred during the high PM_{2.5} concentration events is investigated later in this section.

Table 12: Wintertime Ambient Air Temperatures in Ravalli and Adjacent Counties, 2004 – 2006.

| County – State (Site, ID) | Year | Ambient Air Temperature (°F) ¹ | | | | | | | | |
|--|------|---|----------|----------|---------|----------|----------|---------|----------|----------|
| | | Minimum | | | Maximum | | | Average | | |
| | | January | February | December | January | February | December | January | February | December |
| Ravalli - MT (Stevensville, 247894) ² | 2004 | 14.2 | 22.4 | 20.8 | 29.6 | 42.9 | 38.8 | 23.1 | 31.0 | 31.1 |
| | 2005 | 13.4 | 17.0 | 12.6 | 35.5 | 46.1 | 30.0 | 29.1 | 29.4 | 24.2 |
| | 2006 | 27.5 | 22.1 | 19.9 | 44.1 | 41.9 | 34.2 | 35.0 | 31.2 | 24.1 |
| Beaverhead - MT (Dillon Airport, 24138) ³ | 2004 | 11.4 | 16.9 | 17.8 | 30.1 | 36.4 | 39.0 | 20.8 | 26.7 | 28.4 |
| | 2005 | 12.6 | 17.2 | 11.6 | 33.9 | 44.3 | 29.3 | 23.3 | 30.8 | 20.5 |
| | 2006 | 19.7 | 13.4 | 14.4 | 37.3 | 36.2 | 36.1 | 28.5 | 24.8 | 25.3 |
| Granite - MT (Philipsburg Ranger Station, 243002) ² | 2004 | 13.4 | 15.0 | 19.9 | 31.1 | 34.3 | 37.1 | 23.8 | 23.9 | 29.1 |
| | 2005 | 14.7 | 15.1 | 12.2 | 34.4 | 42.0 | 30.7 | 26.0 | 27.6 | 23.8 |
| | 2006 | 25.5 | 13.1 | 14.3 | 38.9 | 34.7 | 32.5 | 31.2 | 23.4 | 23.6 |
| Missoula - MT (Missoula International Airport, 24153) ³ | 2004 | 14.8 | 21.9 | 22.9 | 27.0 | 36.8 | 36.5 | 20.9 | 29.4 | 29.7 |
| | 2005 | 14.5 | 20.2 | 12.6 | 29.5 | 41.5 | 26.5 | 22.0 | 30.9 | 19.6 |
| | 2006 | 27.7 | 18.8 | 18.9 | 40.3 | 36.9 | 32.7 | 34.0 | 27.9 | 25.8 |
| Idaho - ID (Grangeville, 24139) ³ | 2004 | 24.1 | 25.4 | 26.0 | 35.4 | 39.3 | 40.5 | 30.0 | 32.6 | 33.4 |
| | 2005 | 24.5 | 24.4 | 21.0 | 39.2 | 44.3 | 35.0 | 32.1 | 34.5 | 28.3 |

DRAFT

| County – State (Site, ID) | Year | Ambient Air Temperature (°F) ¹ | | | | | | | | |
|------------------------------|------|---|----------|----------|---------|----------|----------|---------|----------|----------|
| | | Minimum | | | Maximum | | | Average | | |
| | | January | February | December | January | February | December | January | February | December |
| | 2006 | 30.1 | 22.7 | 22.3 | 42.6 | 39.6 | 37.5 | 36.6 | 31.4 | 30.2 |

¹ °F = degrees Fahrenheit.

² Western Regional Climate Center. Monthly Summary. ONLINE: (<http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?mtMSTE>).

³ National Climatic Data Center. Monthly Summary. ONLINE: (<http://www.ncdc.noaa.gov/oa/ncdc.html>).

⁴ Incomplete data set, seven missing days.

Most of the average ambient air temperatures recorded in Ravalli County (Stevensville Ranger Station) during the 2004 through 2006 wintertime were higher than the corresponding temperatures measured at the Missoula International Airport, Missoula County. The one exception was the January average minimum air temperatures. In this case, the ranger station temperatures were consistently lower than at the airport. The ranger station and the airport elevations are 3,365 feet (~1,026 m) and 3,192 feet (~973 m), respectively, a difference of 173 feet (~53 m). One would expect ambient air temperatures to decrease with increasing elevation. These data may indicate that the Missoula valley is experiencing atmospheric inversion layer conditions in which colder air is being trapped by warmer upper air conditions. The graphic representations of the each wintertime month (January, February, and December) minimum, average, and maximum ambient air temperatures by county for the years 2004 through 2006 are shown in Figure 3.

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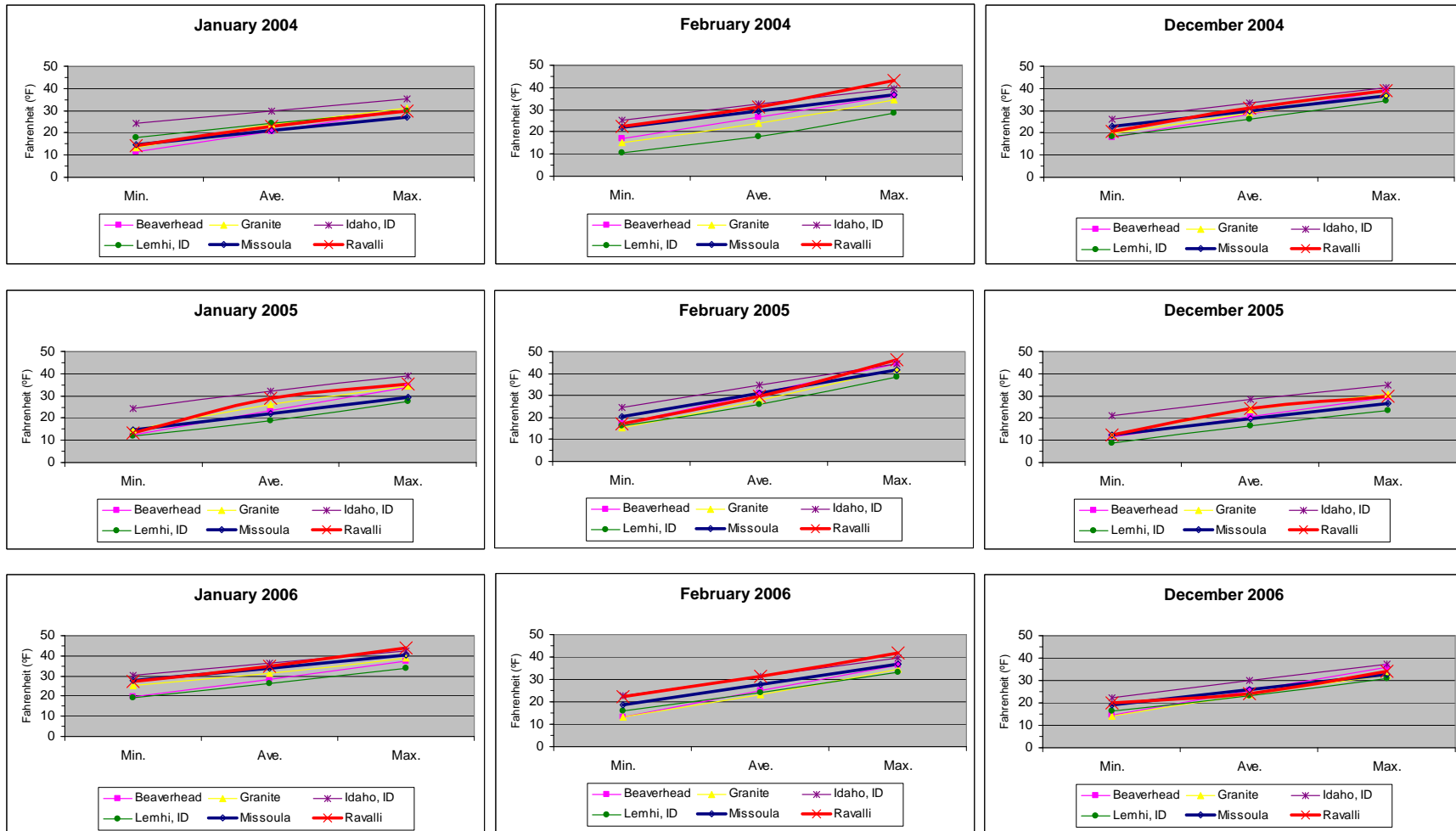


Figure 3: Ambient Wintertime Minimum, Average, and Maximum Temperatures in Ravalli and Adjacent Counties, 2004 – 2006.

DRAFT

Table 13 provides the average prevailing wintertime wind directions and average wind speeds by county. In this case, the wintertime months were combined.

Table 13: Prevailing Wintertime Wind Directions and Wind Speeds for Ravalli and Adjacent Counties, 2004 – 2006.

| County - State (Site, ID) | Wind Direction (%) | | | | | | | | Average Wind Speed (mph) ¹ |
|---|--------------------|------|------|------|------|------|------|------|--|
| | N | NE | E | SE | S | SW | W | NW | |
| Ravalli - MT (Stevensville, 247894) ² | 15.9 | 15.0 | 11.9 | 16.0 | 25.2 | 9.3 | 2.1 | 4.6 | 2.5 ³ |
| Beaverhead - MT (Dillon Airport, 24138) ⁴ | 0.4 | 5.6 | 3.0 | 2.2 | 46.4 | 42.0 | 0.4 | 0.0 | 9.0 |
| Granite - MT (Phillisburg Ranger Station, 243002) ² | 4.7 | 7.4 | 9.3 | 19.5 | 51.0 | 5.4 | 2.3 | 0.4 | 3.7 |
| Missoula - MT (Missoula International Airport, 24153) ⁴ | 8.1 | 2.2 | 11.4 | 19.9 | 7.8 | 4.8 | 21.4 | 24.4 | 3.7 |
| Idaho - ID (Grangeville, 24139) ^{4, 5} | 1.2 | 8.0 | 13.2 | 13.2 | 12.7 | 36.8 | 13.3 | 1.6 | 7.6 |
| Lemhi - ID (Salmon County Airport, 24196) ⁴ | 75.4 | 2.0 | 2.8 | 7.0 | 5.5 | 3.8 | 1.9 | 1.6 | 3.2 |

¹ mph = miles per hour.

² RAWs USA Climate Archive. ONLINE: (<http://www.raws.dri.edu/>).

³ December 2006 data were unavailable.

⁴ National Climatic Data Center. Monthly Summary. ONLINE: (<http://www.ncdc.noaa.gov/oa/ncdc.html>).

⁵ Data were only available for December 2005, and January and February 2006.

DRAFT

The dominant wind directions for Ravalli County were the south (25%) followed by southeast (16%), north (16%), and northeast (15%), respectively. Lemhi County is south of Ravalli County, but Salmon, which is the only substantial town near Ravalli County, is about 30 miles south from the Montana state border. For Missoula County, the dominant wind direction was the northwest, west, and southeast, respectively, not in the direction towards Ravalli County. For the other Montanan counties, winds from the south dominated. From this analysis, PM_{2.5} emissions within the adjacent counties are not contributing factors to the high PM_{2.5} levels in Ravalli County.

For the final meteorological analysis, the days with PM_{2.5} concentrations greater than 35.0 µg/m³ (Table 2) in Ravalli County were evaluated. In addition, for the three days that Missoula County also measured high concentrations, the corresponding data were also presented. Table 14 lists the corresponding minimum, maximum, and average ambient air temperatures for the days of interest.

Table 14: Ravalli County Wintertime Ambient Air Temperatures During Days of High PM_{2.5} Concentration and Corresponding Missoula County Data, 2004 – 2005.

| County (Site, ID) | Date | Ambient Air Temperature (°F) ¹ | | |
|---|----------|--|---------|---------|
| | | Minimum | Maximum | Average |
| Ravalli – MT (Stevensville, 247894) ² | 1/01/04 | 7 | 20 | 15 |
| | 1/10/04 | 11 | 28 | 18 |
| | 1/16/04 | 14 | 38 | 23 |
| | 1/10/05 | 11 | 25 | 17 |
| | 1/16/05 | 4 | 20 | 13 |
| | 12/12/05 | 2 | 20 | 10 |
| Missoula (Missoula International Airport, 24153) ³ | 1/10/04 | 11 | 26 | 19 |
| | 1/16/04 | 13 | 30 | 22 |
| | 12/12/05 | 23 | 42 | 33 |

¹ °F = degrees Fahrenheit.

² RAWS USA Climate Archive. ONLINE: (<http://www.raws.dri.edu/>).

³ National Climatic Data Center. Monthly Summary. ONLINE: (<http://www.ncdc.noaa.gov/oa/ncdc.html>).

DRAFT

Two days that recorded high PM_{2.5} concentrations in both counties (1/10 and 1/16/04) had somewhat similar ambient temperatures in comparison to the third day (12/12/05). The following table characterizes the wind (direction, average speed, and percentage of calms) for the six days with high PM_{2.5} concentrations measured by the Stevensville monitor and the three days Missoula County had in common with Ravalli County. Those three days were emphasized in bold for Ravalli County.

Table 15: Characterization of Wintertime Winds during High 24-hour PM_{2.5} Concentration Days, Ravalli and Missoula Counties, 2004 – 2005.

| County (Site, ID) | Date | Wind Direction (%) | | | | | | | | Average Wind Speed (mph) ¹ | Percent Calm Winds (%) |
|---|-----------------|--------------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|--|---------------------------------|
| | | N | NE | E | SE | S | SW | W | NW | | |
| Ravalli - MT (Stevensville, 247894) ² | 1/01/04 | 8.4 | 0.0 | 4.2 | 12.5 | 20.8 | 25.0 | 12.5 | 16.6 | 1.1 | 42 |
| | 1/10/04 | 12.5 | 20.8 | 37.5 | 12.5 | 12.5 | 0.0 | 4.2 | 0.0 | 1.4 | 8 |
| | 1/16/04 | 4.2 | 12.5 | 12.5 | 25.0 | 25.0 | 4.2 | 8.3 | 8.3 | 1.2 | 29 |
| | 1/10/05 | 12.5 | 20.8 | 4.2 | 16.7 | 12.5 | 20.8 | 8.3 | 4.2 | 0.7 | 50 |
| | 1/16/05 | 36.3 | 13.6 | 13.6 | 4.6 | 13.6 | 4.6 | 4.6 | 9.1 | 0.9 | 46 |
| | 12/12/05 | 16.7 | 12.5 | 8.3 | 8.3 | 29.2 | 8.3 | 12.5 | 4.2 | 1.0 | 29 |
| | OVERALL | 15.1 | 13.4 | 13.4 | 13.3 | 18.9 | 10.5 | 8.4 | 7.0 | 1.1 | 34 |
| Missoula (Missoula International Airport, 24153) ³ | 1/10/04 | 59.3 | 0.0 | 11.0 | 18.7 | 3.3 | 0.0 | 1.1 | 6.6 | 1.7 | 58 |
| | 1/16/04 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | < 1.0 | 0.0 | 0.0 | 0.1 | 99 |
| | 12/12/05 | 59.3 | 0.0 | 11.0 | 18.7 | 3.3 | 0.0 | 1.1 | 6.6 | 1.2 | 75 |
| | OVERALL | 59.3 | 0.0 | 11.0 | 18.7 | 3.3 | 0.0 | 1.1 | 6.6 | 1.0 | 77 |

¹ mph = miles per hour.

² RAWs USA Climate Archive. ONLINE: (<http://www.raws.dri.edu/>).

³ National Climatic Data Center. Monthly Summary. ONLINE: (<http://www.ncdc.noaa.gov/oa/ncdc.html>).

Generally, during the days with high PM_{2.5} concentrations, extremely low wind speeds accompanied with a high percentage of calm winds occurred, especially in Missoula. In Ravalli County, the wind seemed to just swirl about in no particular direction. Under these conditions, it seems highly unlikely there was any exchange of emissions from either county. It is much more likely that the two counties were experiencing the same atmospheric conditions that induced temperature inversions such as high pressure systems resulting in high PM_{2.5} concentrations.

Factor 7: Geography / Topography

Ravalli County is located on the western edge of Montana, in a protected valley, orientated north-south between two mountain ranges: the Sapphire Mountain range to the east and the Bitterroot National Forest to the west. The elevation ranges from 3,200 feet (ft) at the north end of the valley to 10,157 ft on Trapper Peak in the mountains at the south end of the valley. The elevations at the Ravalli County Airport, Hamilton, and the Stevensville Airport are 3,642 and 3,610 ft, respectively.¹³ The Bitterroot Valley is about 96 miles long and 20 miles wide at its mid-section, covering 2,394 square miles of land area. The Bitterroot River runs north from its source until it reaches the Clark Fork River in the Missoula Valley.

The topographic changes vary considerably between the northern and southern portion of the Bitterroot Valley as seen in Figure 4. The northern end of the Valley is relatively flat and open, considerably wider than the southern portion with panoramic views overlooking agricultural land and towns. The southern end of the Valley narrows and is barely five miles wide where the Bitterroot River splits into the East and West Fork Bitterroot Rivers. The steep gradient of many hills prevents development since the Ravalli County subdivision regulations prohibits construction on any slopes 25 percent of greater (Cyra Cain, DEQ, personal communications, John Lavey, Ravalli County, October 1, 2007).

The topographic features surrounding Ravalli County make several of the nine factors insignificant for this proposed nonattainment area boundary analysis, especially those addressing adjacent population centers. For example, the entire Bitterroot Valley is outlined with mountains on either side. To the west is the Bitterroot Range and the Selway-Bitterroot Wilderness Area with the nearest population center at the Lewiston-Orofino-Grangeville Idaho area located approximately 130 miles due west of Hamilton. To the south and east, the Sapphire Mountains and the Anaconda-Pintler Wilderness Area are also without significant population centers. The west side of the valley is cut

¹³ AirNav.Com. Ravalli County and Stevensville airports. ONLINE: (<http://www.airnav.com/airport/6S5> and <http://www.airnav.com/airport/32S>).

DRAFT

with numerous deeply-carved granite canyons, such as Blodgett Canyon. Figure 4 show the isopleths for the following elevations in feet: 4,000, 5,000, and 7,000.

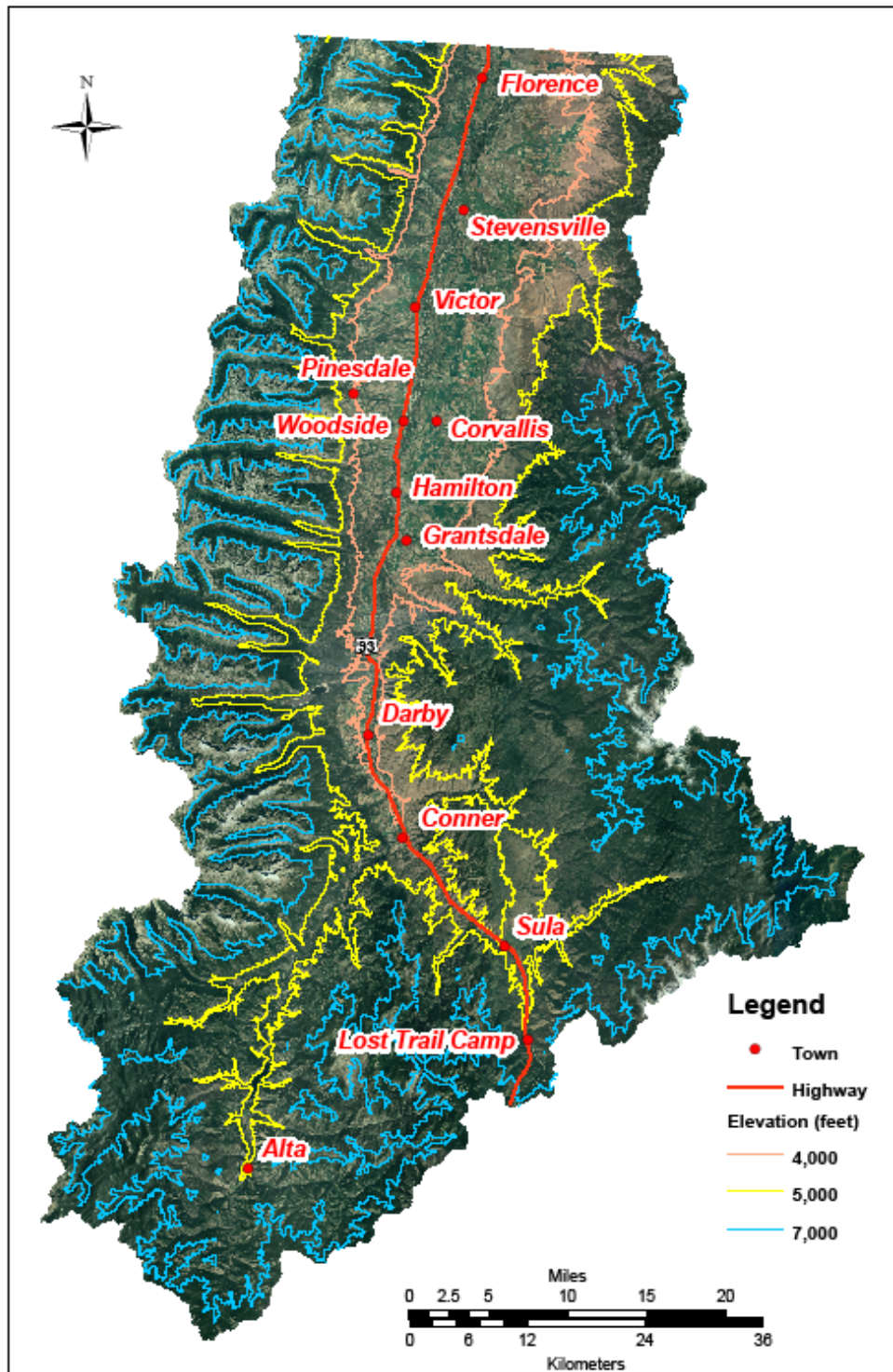


Figure 4: Map of Ravalli County Topography.

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These topographic features and limited surrounding population centers limit the predominant sources of particulate emissions to area sources within the Bitterroot Valley or those affecting the valley from adjacent forest lands in the form of smoke from outdoor burning or wildfires. In addition, as noted previously, wildfire particulate emissions cannot be considered for determining nonattainment boundaries. However, DEQ included all of the public forest lands in the proposed Ravalli County PM_{2.5} nonattainment area for conservative purposes.

Factor 8: Jurisdictional Boundaries

Given the nature of PM_{2.5} as a regional rather than localized pollutant, the Ravalli County PM_{2.5} nonattainment area will extend north to the Missoula-Ravalli County line and be contiguous to the Missoula PM_{2.5} nonattainment boundary. This action may create the potential for jurisdictional and enforcement opportunities and/or difficulties because these nonattainment areas would remain under the separate jurisdictions of each county.

This necessity of maintaining separate nonattainment areas allows each county to develop strategies to reduce PM_{2.5} pollution that are most appropriate to each individual county and to implement processes that recognize the regulatory, political, and financial realities specific to each county.

Missoula and Ravalli Counties are not only physically separate, but the history of air pollution and regulation within each county is considerably different. Missoula has a long history of both severe air pollution and extensive experience in the implementation of a formal air quality program and regulations. In contrast, Ravalli County, to date, does not have an air pollution control program operating within the county. Missoula County is currently designated as nonattainment for PM₁₀ and is in maintenance status for Carbon Monoxide (CO) emissions.

Notably, the current and former nonattainment boundaries for these pollutants center on the city of Missoula, and do not include the more remote parts of the county. Missoula County implemented control measures to reduce the emissions of both of these pollutants, and has not violated either of these standards since the early 1990s. In fact, the Missoula County CO nonattainment area was officially redesignated to attainment on August 17, 2007 at 72 FR 46158. By contrast, Ravalli County has not been designated as nonattainment for any air pollutant.

Additionally, the nature of PM_{2.5} exceedances differs in each county. Therefore, control measures may differ as well. Each county understands the causes of air pollution within its own boundaries and also possesses the best understanding of the political landscape. Both counties will collaborate on control measure development with DEQ taking the lead role to help facilitate collaboration between counties.

DRAFT

Factor 9: Level of Existing Control of Emission Sources

No major permitted source exceeding 250 tons per year of any regulated pollutant were located within Ravalli County, 2004 through 2006. However, three minor sources were permitted in the county during that period: Bitterroot Pet Crematorium (AIRS 3 30-081-006), Rocky Mountain Laboratories (AIRS #30-081-005), and Specialty Surgical Products, Inc. (AIRS # 30-081-007). The acronym AIRS represents Aerometric Information Retrieval System, which the EPA changed to the Air Facility Subsystem (AFS) database dedicated to tracking the compliance of stationary sources of air pollution with the EPA regulations. These three facilities and associated emissions in tons per year for each year are given in Table 16. The listed ambient air pollutants in this table are SO₂, nitrogen dioxides (NO₂), VOCs, NH₄, and PM₁₀. Note that the particulate emissions are PM₁₀, not PM_{2.5}, since DEQ did not require reporting of fine particulates at that time.

Table 16: Ravalli County Permitted Minor Sources with 2005 Annual Emissions.¹

| Source | Pollutant (tpy) ² | | | | | | | | | | | | | | | | | |
|-----------------------------------|---------------------------------|-----------------|--------|-----------------|------------------|-------|-----------------|-----------------|--------|-----------------|------------------|-------|-----------------|-----------------|--------|-----------------|------------------|-------|
| | 2004 | | | | | | 2005 | | | | | | 2006 | | | | | |
| | SO ₂ | NO ₂ | VOC | NH ₃ | PM ₁₀ | Total | SO ₂ | NO ₂ | VOC | NH ₃ | PM ₁₀ | Total | SO ₂ | NO ₂ | VOC | NH ₃ | PM ₁₀ | Total |
| Bitterroot Pet Crematorium | 0.02 | 0.05 | < 0.01 | | 0.02 | 0.09 | 0.02 | 0.06 | < 0.01 | | 0.03 | 0.11 | 0.02 | 0.05 | < 0.01 | | 0.02 | 0.09 |
| Rocky Mountain Labs | 0.52 | 8.28 | 0.85 | 0.22 | 0.42 | 10.29 | 0.56 | 8.18 | 0.94 | 0.21 | 0.48 | 10.37 | 1.93 | 13.09 | 1.16 | 0.23 | 0.63 | 17.04 |
| Specialty Surgical Products, Inc. | | | 13.36 | | | 13.36 | | | 8.48 | | | 8.48 | | | 6.77 | | | 6.77 |

¹ DEQ. Emission Inventory Summary. DEQ Air Resources Management Bureau.

² tpy = tons per year.

DRAFT

Combining all three minor industrial sources together, the total amount of emissions was less than 25 tons per year, regardless of the year. The DEQ believes these sources do not contribute a significant amount of PM_{2.5} emissions within the Bitterroot Valley. Figure 5 show the locations of the three industrial sources, communities, and the U.S. Highway 93.

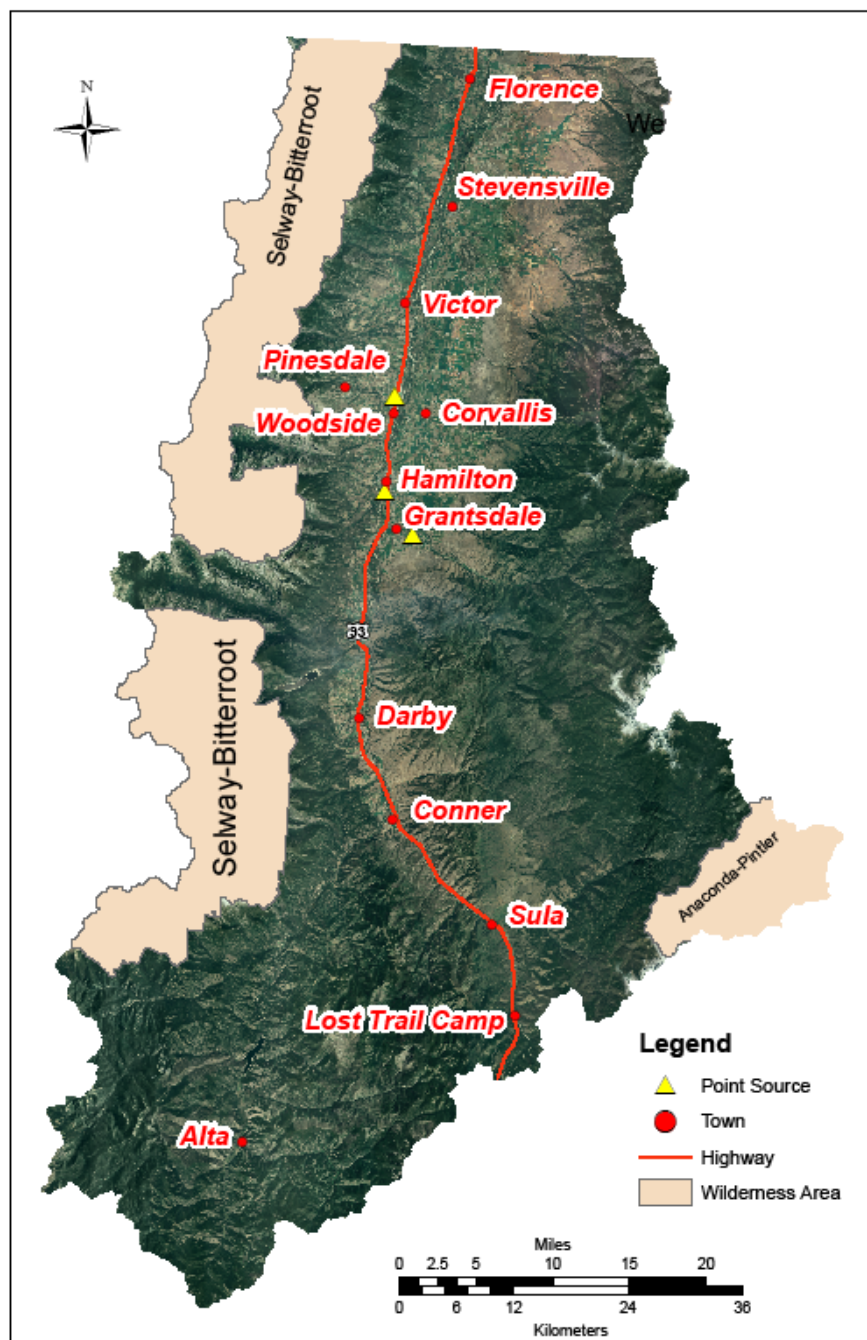


Figure 5: Ravalli County Industrial Sources, Communities, and U.S. Highway 93.

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The final figure, Figure 6, shows the relationship of Ravalli County to the adjacent counties.

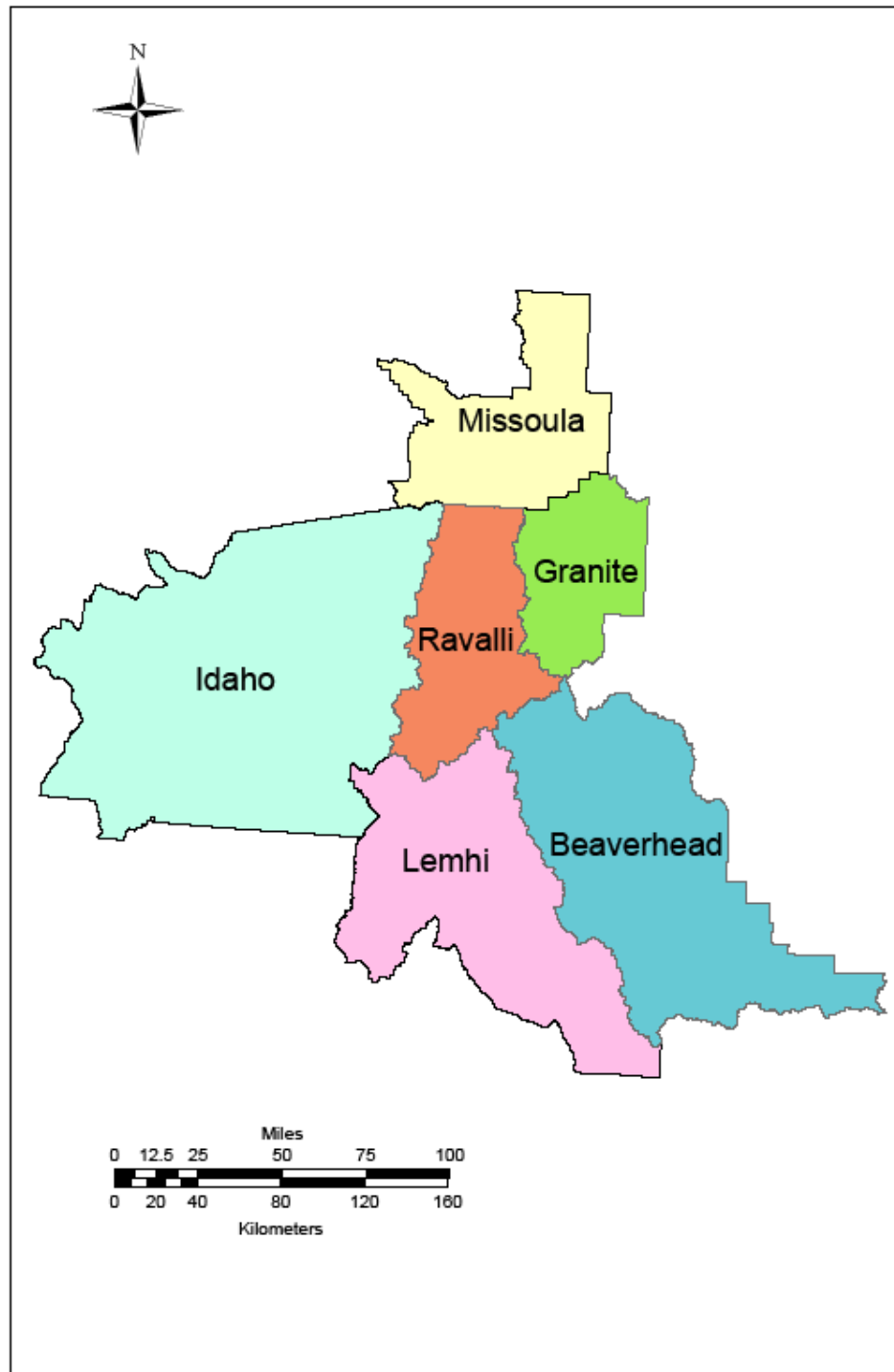


Figure 6: Ravalli and Adjacent Counties.